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cluster. There is some analogy in this object to the planetary nebula. R.A. $4^h 7^m$, P.D. 103° 9′:—in this, however, there is only one stratum of nebula. Its form is circular, with a star or stellar nucleus, nearly, but not quite, in the centre. There is also another fainter star within the nebula, and rather nearer the centre than the circumference. About the third of the area around the centre is darker than the rest, *i.e.* there is less nebula there. An astonishing and interesting object.

"*Tuesday*, 11*th Jan.* Surveyed again the cluster and nebula. R.A. $7^h 34^m$, P.D. 104° 20′. The star is not in the centre, and the nebula seems to retreat from the star, leaving it on a much darker ground than the external parts of the nebula. With slight attention another star is seen; and two or three points or bright spots in the nebula occasionally catch the eye. The cluster fills the field and is rich. The stars in the nebula seem dull."

Remarks on Hooke's Observations of the Comets of 1680 *and* 1682.

By the Editor.

It will be recollected that, on the occasion of the last apparition of Halley's Comet towards the close of the year 1835, a series of extraordinary physical changes were witnessed in the head of the comet as it continued to approach the perihelion. These consisted of irregular emanations of a luminous substance from the nucleus, which, after advancing a short distance towards the sun, as if attracted towards that body in obedience to the principle of gravitation, then curved backwards, as if impelled by some force of great intensity in the opposite direction. This outstreaming cone of luminous matter presented the appearance of a sector, and as such was generally described by observers. This sector was found to vary in breadth from night to night, and the axis to oscillate on each side of a mean direction, coinciding with the radius vector of the comet: even in the course of a single night the axis was observed to undergo very sensible oscillations. No parallel to these singular phenomena could be found in the observations of any comet of recent times. The great comet of 1811 presented a totally different aspect, as is manifest from the observations of Sir William Herschel and other astronomers. During its visibility the head of that comet was observed to be bounded by a bright line which extended back on each side towards the tail; but this line did not appear to have any connexion with the nucleus, nor was the latter perceived to be subject to those tumultuous changes which so strikingly characterised the nucleus of Halley's Comet. The only former comet mentioned by Bessel, as having exhibited analogous phenomena, was the great comet of 1744, as observed by Heinsius.

Having lately had occasion to make some researches in the writings of Hooke, I was astonished to find in the "Posthumous Works" of that philosopher, an account of his observations of the comets of 1680 and 1682, which, in so far as regards the physical

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changes above referred to, tallies completely with the observations of the comet of 1744 by Heinsius, and with the numerous observations of Halley's comet by Bessel and others in 1835. The comet of 1680 was observed by Hooke with a 14-foot telescope on several evenings between the 29th of December in that year and the 10th of the following January. The description which he gives of a stream of light which was seen by him issuing from the nucleus "*in the manner of a sudden spouting of water out of an engine,*" and of the incessant fluctuations to which it was subject, exhibits a most satisfactory agreement with the records of the physical changes observed in the head of Halley's comet on the occasion of its last approach to the perihelion in 1835. The account given by Hooke respecting his observations of the comet of 1682 (which was one of the former apparitions of Halley's comet), is even still more precise on this point. He commenced his observations on the 16th of August, and continued them with more or less interruption till the 10th of September. The following is the account given by him of the appearance presented by the comet on the 26th of August. It is to be borne in mind that the passage of the perihelion took place on the 15th of the following month :—

> "Aug. 26. At seven in the evening I delineated the figure and shape of the comet, exactly like that I saw through my 14-foot telescope, which will appear more plain by the fifth figure than I can otherwise well express it.* It had a pretty bright round nucleus, and about that was an atmosphere of thinner light, which was terminated towards the sun with a round figure. That part of this halo, or lighter atmosphere towards the sun, was not so bright and radiant as another kind of light *which seemed to issue from the nucleus or star both ways at right angles with the axis through the sun;* which lighter issuings bent into a kind of parabolic figure, within the former halo or atmosphere, and was terminated within it, and seemed to form, as it were, a second parabolical termination towards the sun, in the apex of which parabola was the bright nucleus, and this brighter parabolical line of light *seemed as gross or thick as the nucleus itself.* This issued on both sides, but that on the right hand, or the northernmost, was much more conspicuous; insomuch that that on the left hand, or towards the south, was to be seen but sometimes, but that on the other side was very plain and conspicuous, *and seemed like a stream of flame blown out of a candle by a blow-pipe, ascending or bending upwards, just as such a blown flame of a candle will do, if it be made by a gentle blast.* This I remarked very carefully, to see whether I could find by any succeeding observations, any alteration of the magnitude, figure, brightness, or position, in respect of the comet's axis.
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> "These two bright spoutings of flame or light turned or bent upwards from the sun, and after a short space seemed to unite into the axis or middle of the blaze, and form the shape of the outside of a flame of a candle, tapering to a point; the fainter part, also, without it, seemed to taper much in the same manner. I saw also several coruscations or flashings of the flame, shooting out to a great distance into the blaze."

It appears from Bessel's observations of Halley's comet in 1835, that the angular magnitude of the luminous sector, or, in other words, the angle of divergence of the luminous emanation, underwent continual variations. The following observation of Hooke's, relative to the comet of 1682, affords a confirmation of the same fact :—

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* These drawings, to which he refers, are given in his "Posthumous Works."

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"Aug. 29. I observed the body of it through a 14-foot telescope, and saw the spoutings out of the brighter streams from the nucleus, but especially of that on the right or northern side, which was very large and conspicuous; that on the left or south side being much fainter and less conspicuous. *They seemed not now at right angles with the axis, but to be somewhat more towards the sun, both of them; but close by the nucleus they turned about again, and extended into the blaze with a kind of tapering form, as on the* 26*th*, and in all other particulars it seemed to be much the same as it then appeared. For it seemed, as I said before, like a stream of light, or flame, or fusee, issuing more especially on the right or northern side, and *turning about into the blaze*, where it made a kind of tapering light; but the opposite side was not near so plain or easy to be seen."

The observations of the comet on the following evening, when compared with the above description, afford sufficient evidence of the existence of continual changes in the head and nucleus:—

"August 30th. I viewed it again with my 14-foot tube, and found its figure such as I have described in the draught. The halo or atmosphere about the head, on that side which was next the sun, *was thinner than the last time I saw it, not spreading so far that way as then.* The fusee or stream on the north side of it was very plain and bright, *but seemed not to issue now at right angles with the axis of the blaze; but, as it were, at* 45° *with it*, and then bent into the blaze with a kind of parabolic figure, and so ran parallel with the axis to a great length, and did not taper on towards it as on the 29th."

The appearance presented by the comet on the 31st of August accorded with the observations of the preceding evening, except that "the fusee or stream of light seemed now to run farther parallel to the axis into the blaze." Its aspect on the 1st of September is thus described by Hooke:—

"Sept. 1. I viewed it again with my 14-foot telescope. I could see no small stars near it; the fusee or stream of light appeared much as it had done the two preceding nights. I still plainly saw the flaring or flashing of the light, and sometimes also saw a shooting or spouting, as it were, of light from the nucleus directly into the blaze, which as quickly disappeared."

The observations of September 4 clearly indicate the existence of an *oscillation of the luminous fusee*, as was remarked by Bessel in the course of his observations of the same comet in 1835:—

"Sept. 4. The nucleus was pretty clear and round, but the blaze from it was only two emanations of a kind of parabolic figure on each side, as in the figure; but the northern side was brighter than the southern still, and they seemed to spread over one from another with an angle of 60°, so far as I could see them then; for they extended but a little way from the nucleus. The middle part of the blaze between them was hardly visible. But, as the crepusculum diminished, it appeared much brighter and fuller, and then I could see its light also in the middle part of the blaze. Scarcely any halo between the nucleus and sun appeared at first, and but little more when it appeared brightest. I observed also the flaring or flashing of the light, *and a kind of moving of the fusee on the north side.*"

Hooke sums up the results of his observations of the two comets of 1680 and 1682, in a series of statements, of which the following is chiefly worthy of attention, inasmuch as it embodies the most important features of the phenomenon:—

"Secondly, that there is a gravitation *towards*, and a levitation *from* the sun. For, as I have by many observations shown, though there be a descent of the

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streams from the nucleus towards the sun, yet I always plainly saw that they quickly returned, and went contrary and opposite to the sun, and that sometimes to a prodigious extent."

Compare this statement with the following by Bessel relative to the apparition of Halley's comet in 1835, and to the comet of 1744 as observed by Heinsius :—

> " My observations of the comet made on the 22d of October, and the more complete observations of the comet of 1744 by Heinsius, show that the particles emitted by the comet in a direction making an acute angle with the radius vector, cease after a certain lapse of time to *approach* the sun, and then *recede* towards the tail in a direction opposite to the latter body."

Nothing can be more satisfactory than the accordance here exhibited respecting the physical changes observed in the comets of 1680, 1682, 1744, and 1835. It may be remarked that similar changes were witnessed by M. Julius Schmidt, in the head of the third comet of 1853, on the occasion of its approach to the perihelion towards the end of August last year.

Bessel remarks, that in both the comets of 1744 and 1853 the nucleus had an oval form, the longer axis of which was directed towards the sun. The observations of Hooke are not very precise on this point; but the following statement by Hevelius respecting the appearance of the same comet serves to make the account of the English philosopher more complete: — " In ipso capite, beneficio longioris telescopii, non nisi unicum nucleum figuræ ovalis et gibbosæ constanter notavimus; nisi quod die Sep. 8 ex dicto nucleo clarissimus simul radius, ex parte etiam incurvatus in caudam exiret." (*Annus Climactericus*, p. 123.) This is the only passage of the account of the comet given by Hevelius, which contains any allusion to the luminous emanation from the nucleus. As regards the *physical changes* which Hooke observed from night to night, the celebrated astronomer of Dantzic does not seem to have had any cognizance of their existence beyond what may be inferred from the foregoing statement.

With respect to the apparition of Halley's comet in 1835, Bessel remarks that the direction of the outstreaming luminous cone generally made an acute angle with the radius vector of the comet, whereas, in the case of the comet of 1744, it appeared to have issued from the nucleus at all angles, making at one time even a right angle with the radius vector. The comet of 1682 exhibits in this respect a close analogy to the latter comet, as is manifest from the foregoing passages which have been cited, from Hooke's account of its appearance.

A curious feature witnessed during the apparition of the comet of 1835 was the oscillation of the axis of the outstreaming luminous cone to and fro on each side of the radius vector of the comet. Bessel remarks that Heinsius makes no allusion to a similar phenomenon having been visible on the occasion of the apparition of the comet of 1744. We have seen that the observations of the comet of 1682, made by Hooke on the 4th of September, exhibited an unequivocal indication of such an oscillatory movement.

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After I became acquainted with the remarkable observations of Hooke relative to the comets of 1680 and 1682, from which the foregoing passages have been extracted, I endeavoured to ascertain whether they had been alluded to by any modern writer. I expected, more especially, that phenomena of so striking a character as those recorded by the English philosopher could hardly have escaped the attention of Olbers, who was so intimately conversant with the literature of cometary astronomy. I found, in fact, that the venerable astronomer of Bremen has alluded to Hooke's observations of the comet of 1682, in a paper relative to the approaching apparition of Halley's comet, published about the beginning of the year 1835, in vol. xii. of the *Astronomische Nachrichten*, p. 57, *et seq.*, but he seems to have entirely overlooked those tumultuous changes which Hooke perceived the comet to be subject to when examined from night to night, and which serve *exclusively* to establish the analogy between its physical condition and that of the comets of 1744 and 1835. This, however, cannot excite any surprise when it is borne in mind that the paper in question was written *previously* to the last apparition of Halley's comet. The object of Olbers was to ascertain how soon the comet might probably become visible by a reference to the records of former apparitions, and he cites Hooke's observations of the comet of 1682 solely on account of the evidence of the brightness of the head which they afford. With respect to the physical aspect of the comet as recorded by Hooke he merely takes occasion to state that the head was bounded by a parabolic line of light *like the comet of* 1811, only that in the case of the comet of 1682 there was no interval visible between this bounding line and the nucleus.

Imagining that the extraordinary physical changes witnessed by Bessel and other astronomers in the head of Halley's comet on the occasion of its actual apparition in the autumn of 1835, might have had the effect of drawing the attention of the Nestor of cometary astronomy to the analogous changes observed by Hooke in the comets of 1680 and 1682, I consulted for this purpose the recently published *Correspondence of Olbers and Bessel.** In a letter from Bessel to Olbers, dated the 25th of October, 1835, the illustrious astronomer of Königsberg gives a detailed account of the singular appearances which he had recently witnessed in the head of Halley's comet. The following passage, extracted from a long letter written in reply by Olbers to Bessel, shows that the infirmities of old age had prevented the writer from enjoying the gratification of personally observing those singular variations which otherwise might have induced him to search for a prototype of them among the records of former apparitions:—

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* "Briefwechsel zwischen, W. Olbers and F.W. Bessel, in zwei Bänden," Leipzig, 1852. A copy of this interesting work has recently been added to the Library of the Society, forming one of the many valuable donations of a similar kind for which the Society is indebted to the Rev. Richard Sheepshanks.

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"Since the 22d of September I have frequently regarded it from my little garden, first with a small comet-searcher by Hoffmann, and afterwards with the naked eye. On two occasions (the 18th and 22d of October) have my servants, with much difficulty, conducted me to my observing chamber, when I perceived the comet with my 5-foot Dollond instrument, but not with a magnifying power of less than forty-four. My bodily infirmities prevented me from applying a higher magnifying power or from using my beautiful 6-foot Fraunhofer. Besides, I dared not remain long exposed to the cold evening air. Of *your wonderful streams of light I have seen nothing.*"*

It is interesting to find that the theory proposed by Hooke, to account for the singular changes witnessed by him in the heads of the comets of 1680 and 1682, agrees mainly with the explanations which have been suggested by Bessel and Sir John Herschel relative to the analogous phenomena observed on the occasion of the apparition of Halley's comet in 1835. That there is an actual ejection of luminous matter from the nucleus seems to have been the firm opinion, not only of Hooke, but also of all modern observers of the same phenomena.† Hooke maintained that the velocity with which the luminous particles seemed to move from the head towards the tail of the comet could only be compared with the velocity of lightning. He supposed, therefore, that by the agency of the solar heat vapours were raised in the head of the comet; and, in accordance with the prevailing notions of his time, he then proceeds to show that the sulphureous and resinous particles, by coming into contact, produced the flame of lightning which propagated itself from the head to the tail in an amazingly short space of time.

The explanation suggested by Sir John Herschel relative to the origin of the same phenomena is contained in a foot-note appended to one of the pages of his *Results of Astronomical Observations made at the Cape of Good Hope*. It is expressed in the following terms:—

"It is prudent, to say the least, in such hypotheses, to keep clear of specialties, yet I cannot help remarking that the conception of a high degree of electrical excitement in the matter of the tail (of the same character with that of a permanent electrical charge, supposed to be resident in the sun), superadded to the ordinary conception of a gravitating nucleus, would satisfy most of the essential conditions of the problem. That the sun's heat in perihelio does actually vaporise a portion of the cometic matter, there can no longer, I think, be any reasonable doubt. That, in such vaporisation, a separation of the two electricities should be effected, the nucleus becoming (suppose) negative and the tail positive, is in accordance with many physical facts. The circumstances of this vaporisation, as they were seen to take place in Halley's comet, were highly favourable to such separation. The matter of the tail seemed to be emitted in violent jets and streams, as if from orifices or fissures in the anterior part of the nucleus, a state of things productive (as recent experiments have shown) of powerful electrical excitement." (*Results of Ast. Obs.* p. 409.)

In reference to an objection that might be urged to this hypothesis, on the ground that it supposes the sun to be in a perma-

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* *Briefwechsel, Zweiter Band*, p. 406.

† "Der Comet stösst die Materie aus, darüber ist kein Zweifel." (Bessel to Olbers, *Briefwechsel, Zweiter Band*, p. 403.)

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nently electrical state, and that, therefore, thunderclouds in our atmosphere ought to be attracted to or repelled from it, and move accordingly, Sir John Herschel remarks, that while the matter of a cloud is vastly more dense than that of a comet, the latter, in all probability, is more powerfully excited than the cloud; and hence, on both these grounds, the motion of the cometic particles ought to be inconceivably swifter than the motion of the cloud. The argument is still further strengthened by the consideration that the cloud moves through a medium which is infinitely denser than that traversed by the comet. It is interesting to find Hooke endeavouring to support his theory by means of an argument closely resembling that which is here employed by Sir John Herschel.*

The views entertained by Bessel respecting the origin of the luminous emanations are somewhat similar to those of Sir John Herschel, as above stated.

With respect to the remarkable appearances which Hooke observed in the comet of 1680, he states that he had never met with any mention of similar phenomena in any author or from any person who had devoted his attention to comets. He adds, however, that he had been told by "*some antient men*" who had seen the great comet of 1618, that it did perfectly sparkle and shoot fire, but he was disposed to attribute this notion to the exaggerated effect produced upon the imagination by the terrific aspect of the comet.

On the Zodiacal Light. By the Rev. T. W. Webb.

The following memoranda of former appearances of the zodiacal light may, perhaps, be thought worthy of preservation, at any rate so far as they may exhibit some correspondence with the observations of Mr. Lowe, in the *Monthly Notices* for November.

"1837, Feb. 23. I think it was about $7^h\ 30^m$, but I am not confident as to the time that I saw the zodiacal light, extending as far as the *Pleiades*, its termination, which was very faint, being, I think, a little to the south of them.

"March 7. About $7^h\ 50^m$, the zodiacal light was again visible, tolerably bright near the horizon, but faint at a greater elevation. It seemed, however, to extend as far as the *Pleiades*, and a little beneath them.

"1839, Jan. 9. The zodiacal light was very visible about $6^h\ 30^m$ p.m., but not well defined; the base was broad, and the point directed towards *Aries*. Its exact extent could not be ascertained, but by oblique vision, by which it was best seen, it appeared to extend beyond, and beneath, γ *Pegasi.*

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* "And though the progress of the flash in comets be probably a thousand times more swift; yet considering the vast difference there is between the air and the ether, I know not but that the progress of the ascension of flame in the lightning may be accounted as quick through the thick medium of air, as that of the comet in the thinner and more fluid medium of ether."—(*Posthumous Works*, p. 170.)